OXYGEN TRANSPORT AND ELECTRODE PROPERTIES OF

$La_2Ni_{0.8}Cu_{0.2}O_{4+\delta}$

E.V. Tsipis, V.V. Kharton, A.A. Yaremchenko, and J.R. Frade

Department of Ceramics and Glass Engineering, CICECO, University of Aveiro, 3810-193 Aveiro, Portugal

High level of oxygen ionic conductivity in solid electrolytes based on lanthanum gallate, in particular $La_{1-x}Sr_xGa_{1-y}Mg_yO_{3-\delta}$ (LSGM), enables their use for intermediate-temperature solid oxide fuel cells (IT SOFCs) operating at 870-1070 K. Further developments of IT SOFCs require a search for new cathode compositions highly active in contact with LSGM. This work is focused on the transport and electrochemical properties of $La_2Ni_{0.8}Cu_{0.2}O_{4+\delta}$, evaluated as a potential cathode material.

The submicron powder of $La_2Ni_{0.8}Cu_{0.2}O_{4+\delta}$ with K_2NiF_4-type structure, having grain size of 30-60 nm, was synthesized via glycine-nitrate process and used for the preparation of porous cathode layers applied onto $(La_{0.9}Sr_{0.1})_{0.98}Ga_{0.8}Mg_{0.2}O_{3-\delta}$ solid electrolyte. In air, dense ceramics of $La_2Ni_{0.8}Cu_{0.2}O_{4+\delta}$ possess thermal expansion coefficient of 13.3×10^{-6} K^{-1} at 400-1240 K, p-type electronic conductivity of 50-85 S/cm at 800-1300 K and relatively high oxygen permeability limited by the surface exchange. These properties provide a substantially high performance of porous electrodes, exhibiting cathodic overpotential lower than 50 mV at 1073 K and current density of 200 mA/cm^2. As for the oxygen transport through dense membranes, the results on electrode behavior, including the overpotential-microstructure relationships and the $p(O_2)$ dependence of polarization resistance, suggest that the cathodic reaction rate is affected by surface-related processes. Due to this, electrode performance can be considerably enhanced by surface activation, particularly via impregnation with Pr-containing solutions, and also by decreasing fabrication temperature. At 873 K, the surface modification with praseodymium oxide decreases overpotential of $La_2Ni_{0.8}Cu_{0.2}O_{4+\delta}$ cathode, screen-printed onto electrolyte and annealed at 1473 K, from 330 down to approximately 175 mV at 50 mA/cm^2.